A.4.9 Energetics and Dynamics of the Mesosphere and Lower Thermosphere: TIMED/CEDAR Collaborative Studies

1. Scope of Program

- Introduction

Understanding the Earth's upper atmosphere is the goal of two complementary programs that are poised to take advantage of joint measurement in the 2000-2001 timeframe. These are the NASA Thermosphere Ionosphere Mesosphere Energetics and Dynamics (TIMED) mission and the NSF Coupling, Energetics and Dynamics in Atmospheric Regions (CEDAR) program.

The TIMED mission, which is scheduled for launch in May 2000, was designed to study the region of the atmosphere between 60 and 180 km altitude. This region constitutes the primary interface between the lower terrestrial atmosphere and the space environment. Although much has been learned from ground-based studies about the processes that control this region, relatively little is known about its global characteristics because atmospheric densities in the region are too great to allow long-term in situ satellite reconnaissance and because the geographical distribution of ground-based observatories is limited.

It was to fill this gap in knowledge that the TIMED mission was designed primarily to determine the temperature, density, and wind structure of the mesosphere/lower thermosphere/ionosphere (MLTI), and to determine the relative importance of the various sources and sinks of energy for the thermal structure of the MLTI.

TIMED has many goals in common with the NSF CEDAR program, which is designed to characterize and understand the atmosphere above 60 km with emphasis on the energetic and dynamic processes determining the basic composition and structure of the atmosphere. Particular attention is given to how these processes are coupled and to the mechanisms that couple different atmospheric regions. Phase III of the CEDAR program has begun and is expected to extend through the next decade. The scientific agenda of CEDAR Phase III has four science initiatives: coupling to lower altitudes, solar-terrestrial interactions, polar aeronomy, and long-term variations, all of which have close ties with TIMED objectives.

The beginning of the new century will be a time of intense activity for both of these programs. The modes of implementation of the TIMED and CEDAR programs, which feature, respectively, space-borne and ground-based instrumentation, are inherently synergistic. Therefore, NASA and NSF wish to take the best possible advantage of the complementary nature of these two programs through the support of correlative studies on the Energetics and Dynamics of the Mesosphere and Lower Thermosphere (EDMLT), which are solicited in this NASA Research Announcement (NRA).

- Thermosphere Ionosphere Mesosphere Energetic and Dynamics (TIMED) Mission

The main scientific objectives of NASA's TIMED mission are (1) to determine the temperature, density, and wind structure in the Mesosphere, Lower Thermosphere, and Ionosphere (MLTI) region (60-180 km), including the seasonal and latitudinal variations ("basic structure"); and (2) to determine the relative importance of the various radiative, chemical, electro-dynamical, and dynamical sources and sinks of energy for the thermal structure of the MLTI region ("energetics"). TIMED has, however, always been a tightly cost-capped mission, and it has been recognized from the beginning that this mission could only make a first step towards fulfilling these overall goals. Nevertheless, this mission as currently configured should provide the core subset of measurements that define, at least to first order, the basic state of the MLTI, but only the major parameters will be measured. Reduced to the most fundamental level, these parameters are the energy input, the energy output, and the major consequences of this energy exchange, namely temperature, winds, and density/composition. Moreover, only the most important physical component of each of these parameters forms the core measurement subset. Finally, in order to ensure that the evolution in physical processes between low and high altitude is addressed, the core measurement subset provides those observations throughout the entire altitude range from 60 to 180 km.

In order to fulfill its goal of providing complete geographic and seasonal coverage of the MLTI, TIMED is scheduled for a two year prime mission. The satellite will be launched into a 74.4^{o} inclination, 625 km circular orbit, thus allowing repetitive observations at specific local times on a regular basis. The following set of investigations has been selected to carry out the TIMED mission.

TIMED Experimental Investigations

GUVI Global Ultraviolet Imager
- Dr. Andrew Christensen/Aerospace Corporation
-- A spatial scanning UV spectrograph designed to measure the composition and density above ~120 km, and auroral energy inputs.

SABER Sounding of the Atmosphere Using Broadband Emission Radiometry
- Dr. James Russell, III/Hampton University
-- A multi channel radiometer designed to characterize infrared radiation, allowing calculation of cooling rates and determination of composition and temperature profiles in the lower altitude portion of the MLTI.

SEE Solar EUV and XUV Spectral Irradiance Experiment for the TIMED Mission
- Dr. Thomas Woods/University of Colorado
-- A suite of photometers and spectrometer designed to measure the solar X-ray, ultraviolet and far ultraviolet input to the MLTI.

TIDI A TIMED Doppler Interferometer
- Dr. Timothy Killeen/University of Michigan
-- A Fabry-Perot Interferometer designed to measure the wind and temperature profiles.

TIMED Interdisciplinary Scientist Investigations

Models of Chemical Dynamical Radiative Interactions in the Mesosphere and Lower Thermosphere
- Dr. Anne Smith/National Center for Atmospheric Research.

Tides, Planetary Waves, and Eddy forcing of the Mean MLT Circulation
- Dr. Jeffrey Forbes/University of Colorado.

A Theoretical and Observational Study of Large- and Small-scale Dynamics in the Mesosphere and Lower Thermosphere in Support of TIMED
- Dr. David Fritts/North West Research Associates.

Solar and Magnetospheric Inputs to the MLTI Region
- Dr. Janet Kozyra/University of Michigan

Dynamics of the Mesosphere and Lower Thermosphere: Empirical and Theoretical Models
- Dr. Hans Mayr/NASA Goddard Space Flight Center.

Energy Transfer in the Thermosphere and Mesosphere
- Dr. Stanley Solomon/University of Colorado.

The Interdisciplinary Scientists are providing theoretical and modeling support with specific goals of integrating data from multiple TIMED instruments and relating the expected results from the TIMED mission to phenomena and processes in adjacent regions of the Earth's atmosphere.

More detailed information on the TIMED instruments and their measurement capabilities and the research interests of TIMED Interdisciplinary can be found at the Web site http://www.TIMED.jhuapl.edu.

- Coupling, Energetics and Dynamics of Atmospheric Regions (CEDAR) Program

The NSF CEDAR program has as its objective to explain how energy is transferred between atmospheric regions by combining a comprehensive measurement program with theoretical and empirical modeling efforts. Initiated in 1987, CEDAR has been guided by a three-phase implementation plan. Phase I entailed a coordinated approach, whereby existing instruments and facilities were used to address topics beyond the scope of single-instrument research. Automation of instruments and upgrades to improve speed and sensitivity were accomplished in Phase II, leading to an expansion of aeronomy research

and broadening of the scientific research scope. Phase III, which has just recently begun, focuses on scientific studies in four areas: coupling with lower altitudes, solar-terrestrial interactions, polar aeronomy, and long-term variations.

CEDAR science depends critically on accurate and reliable observations made by state-of-the-art instrumentation. The CEDAR community has made significant advances in the development of Class I facilities, which consist of optical and radar instrument clusters collectively capable of multi-parameter observations spanning the atmosphere from 60 to 1000 km altitude or more. The most advanced of these clusters are the four incoherent scatter radar sites that are managed by the NSF Upper Atmospheric Facilities (UAF) Program, as follows.

SITE	PRINCIPAL INVESTIGATOR/INSTITUTION
Jicamarca, Peru	Don Farley/Cornell University
Arecibo, Puerto Rico	Paul Goldsmith/Cornell University
Millstone Hill, Massachusetts	John Foster/ Massachusetts Institute of Technology
Sondrestrom, Greenland	Jeff Thayer/ SRI International

In addition to these large facilities, CEDAR science is facilitated by an extensive, globally distributed array of smaller optical and radio wave instruments that provide comprehensive data on atmospheric properties. All data acquired by CEDAR instrumentation are archived in a data base at the National Center for Atmospheric Research (NCAR). Information about CEDAR instrumentation and the data base is available through the CEDAR Web site at http://cedarweb.hao.ucar.edu/index.html.

- Research Opportunity

NASA and NSF are jointly soliciting proposals for investigations of the mesosphere and lower thermosphere. The understanding of this region of the atmosphere is a primary focus of both the CEDAR and TIMED programs, and NASA and NSF wish to take the best possible advantage of the complementary nature of the two programs through the support of correlative studies that use the complementary resources available to both programs in addressing their common science goals. To this purpose, portions of the CEDAR and TIMED Mission Operations and Data Analysis budgets have been dedicated to the support of collaborative studies.

Prospective Collaborative Investigators (CI's) will be expected to demonstrate the importance of their proposed efforts to the science goals of both the TIMED and CEDAR programs. Funding for this effort is intended to support scientific studies that may require activities such as the analysis and coordination of data from satellite and ground-based instruments, data collection and assimilation activities, and interaction with the modeling community. Although proposals for the support of single-instrument data sites are not excluded, proposals that provide for the coordination of a number of investigators and data sets in the attack on a common scientific goal are especially desirable. The establishment of new instrumentation is out of scope for this program.

• Data Policy

The TIMED program data policy calls for complete and immediate public access to all of the TIMED mission data. Commensurately prompt public access to CI data is also important for effective collaborative efforts; therefore, the speed and appropriateness of the data distribution plans will be an important element in the evaluation of proposal merit. Therefore, those CI's proposing to provide data in support of CEDAR/TIMED science must consider the following guidelines relating to data access and distribution:

- CI's have the option of hosting a Web site to distribute their data files or delivering the files as soon as possible to the CEDAR database. Proposals should describe plans for implementing one or both of these procedures and indicate the expected time required for data delivery.
- CI data files should be produced in NetCDF format via the Web or delivered to CEDAR in a format compatible with the CEDAR database. Other data formats will be acceptable provided the proposals make a convincing case that the data can be easily accessed by other users.
- CI proposals should identify the type and quantity of data that will be contributed as part of the CEDAR/TIMED collaborative project. Proposals should describe whether the data will be obtained routinely in a standard data-taking mode, or only during selective campaigns or satellite overpasses necessitating advanced planning of operating modes and instrument configurations.
- Data providers will be expected to provide a text description of the contents, version and quality of the data in each type of data file they produce. This description (called a Data Product Specification) will be under configuration control.
- Data providers will send to the TIMED Mission Data Center a notification of the availability of each data file. This Product Availability Notice is a short fixed format text file describing each data file, including the file's URL. This information will be included in the mission data catalog that allows data users to identify and search mission data products.
- CI's will also be expected to provide information about planned and actual data collection activities in the form of text timeline files.
- CI's who also host Web sites containing the data are expected to provide reliable web access to the data for the life of the TIMED mission with minimal site down-time. These CI's will also support the bulk transfer of all data files for final archiving. These transfers will occur one year after launch, at the end of mission operations, and four months before mission close-out. In addition, these sites should provide site access statistics and share a common user registration database.
- All CI's will be expected to participate in pre-launch data system testing in late 1999 and early 2000, which will involve Web distribution of sample data file.

More detailed information about CI interface requirements is available at the TIMED Web site http://www.timed.jhuapl.edu.

It is anticipated that a number of prospective CI's may want to make use of data from one or more of the incoherent scatter radar facilities listed above. CI's should not make individual arrangements for facility use or to include prospective facility costs within their own budgets. In order to ensure that data from these four incoherent scatter radar facilities are available, however, CI's should contact the PI's of these facilities to discuss their data requirements. Facility PI's will not be able to make firm commitments about the availability of the desired measurements but will advise proposers about the plausibility and reasonableness of the requested data. After selection of proposals, each of the facilities will be provided funding to ensure that an appropriate portion of the required measurements can be made. To aid in the allocation of these resources, proposals must address the following questions:

- How much archived facility data will be used? Can these data be taken from the NCAR CEDAR data base or is additional processing required?
- How many new experiments need to be performed? What are the observational restrictions on the times of these experiments? What operating modes are needed?
- How much data processing is required before the data are in a useable format?
- How much support will be needed from facility staff in conducting the experiments and processing the data?

CI's of EDMLT proposals need not team with members of facility staff in order to ensure access to facility data, although facility staff members may be included as scientific collaborators on a proposed project. Facility PI's and staff members will have no preferred access to facility data or usage and, if they choose to propose as a CI or a member of a CI team, they must provide the information indicated above in the same way as other proposers.

2. Programmatic Considerations

• Investigator Eligibility

- TIMED Principal Investigators (PI's) are not eligible to receive funds from the EDMLT program or to serve as PI's or Co-I's on proposals submitted in response to this NRA.
- UAF staff may be PI's on proposals to this NRA.
- UAF PI's may not be PI's on EDMLT proposals but may be Co-Investigators.
- NSF will not consider funding proposals submitted by institutions that are not traditionally supported by NSF. However, such proposals may be submitted for funding by NASA and, therefore, need not include the NSF forms discussed below.
- Investigators working for non-U.S. institutions are not eligible for funding from either NASA or NSF.

• Funding and Budget Considerations

Successful proposals will by funded by either NSF or NASA, at the Agencies' discretion. Proposers may request funding for tasks lasting up to two years. Funding provided for efforts proposed in response to this program element is intended to support activities that take place during the prime TIMED data-taking period, which is expected to be during the years 2000 and 2001. Proposed budgets are expected to take into account the fact that the TIMED program may begin phasing down in FY 2002. However, if TIMED is approved for an extended mission, then an additional EDMLT solicitation for collaborative efforts for the years 2002 and 2003 may be issued.

The total current joint NASA/NSF funding available for support of this effort will be:

	NASA	NSF	Total
FY 2000	$1.0M	$0.5M	$1.5 M
FY 2001	$1.0M	$0.5M	$1.5 M

It is anticipated that there will be a need to set aside a portion of this funding to offset expenses at supporting facilities, and it is expected that on the order of 10 individual investigations will be supportable from the total remaining funds.

• Proposal Evaluations and Review Criteria

Proposals will be evaluated principally for intellectual merit by peer scientists, by mail and at a joint NASA/NSF review panel meeting. Because the EDMLT Program is a joint NASA/NSF effort, the following augmentations and supplements to Section C.1.4 of Appendix C of the parent NRA 99-OSS-01 are necessary. In case of conflict, the material presented here takes precedence.

(i) Evaluation factors

(1) The evaluation criteria shall be as in Appendix B, Section (i), with the explicit understanding that "NASA's objectives" referred to in Appendix B are the objectives of the EDMLT Program.

(2) Evaluation of intrinsic merit includes consideration of the following factors listed in approximate order of decreasing importance:

- How important is the proposed activity to advancing knowledge and understanding within its own field and across different fields?
- For investigator proposing to provide data, to what extent does the data distribution plan satisfy the guidelines in Section 1 above?
- How well qualified is the proposer (individual or team) to conduct the project?
- To what extent does the proposed activity suggest and explore creative and original concepts?
- How well conceived and organized is the proposed activity?
- Is there sufficient access to resources?

(3) Evaluation of the cost of a proposed effort shall include the realism and reasonableness of the proposed cost, and the comparison of that proposed cost to available funds.

• Additional Guidance for Proposal Preparation and Contents

Since either NASA or NSF may fund any proposal (with the exceptions noted at the beginning of this Section 2), proposers are requested to prepare a single proposal that may be used by either Agency. Therefore, each proposal shall include all forms, starting with the cover pages, as required by both NSF (see the *NSF Grant Proposal Guide*, NSF publication 99-2) and for NASA (see section C.5.3 of Appendix C this NRA 99-OSS-01). Note that the Web site for the submission of the NASA Cover Page will additionally ask for the following information:

- Identification of which TIMED instrument data sets the proposer expects to use;
- Identification of which, if any, UAF facility data sets will be required; and
- A brief description of the types of data to be provided by proposer, including comments on expected data quality and data distribution methods.

• Prior Support

A description of accomplishments achieved under any prior NSF support must be included following the Science Plan.

• Certification Forms. The institutional signatures on both the NASA and NSF Cover Sheet forms certify the compliance of that institution to the required certifications; see NSF 99-2 and Section C.5.3 of NRA 99-OSS-01 for further details.

• Submission Dates and Locations

Notice of Intent due date	April 7, 1999.
Proposal due date:	June 3, 1999.
Number of proposals:	Signed original plus 15 copies

Notices of Intent and NASA Proposal Cover pages should be submitted through the World Wide Web at http://props.oss.hq.nasa.gov/. Proposers without access to the WWW or who experience difficulty, may contact Ms. Debra Tripp (e-mail: deb.tripp@hq.nasa.gov) for assistance.

Hard copies of proposals are to be delivered to:

Mesosphere and Lower Thermosphere Studies
Jorge Scientific Corporation
400 Virginia Avenue, SW
Washington DC 20023
Phone number for commercial delivery: (202) 554-2775

- Further Information

Further information about this EDMLT program can be obtained from:

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